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ABSTRACT

Commonality analysis was used as part of an evaluation of the Preparation through Responsive Educational Programs (PREP), a project based on behavior modification for disruptive, poorly achieving, and potentially delinquent urban junior high school students. The objectives of this study were to understand how the program affected certain academic and non-academic outcomes, and to assess the practicability of commonality analysis. Data were collected over a 3 year period, from 221 youth, 112 of whom participated in PREP and 109 of whom were controls. The major questions in this research have been how much environmental, as opposed to personal, variables contributed to scores on achievement and other school-related behaviors, and the extent to which the PREP program might have affected these scores and behaviors. The results support PREP's techniques for improving English and mathematics classroom performance and argue for a greater emphasis on the social skills aspects of the urban program's curriculum. The use of commonality analysis in evaluating programs such as PREP's urban effort could provide a ready and clear description of where program efforts should be enhanced or changed. (PN)

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A COMMONALITY ANALYSIS: ASSESSING UNIQUE EFFECTS OF PERSON AND ENVIRONMENT VARIABLES ON SCHOOL PERFORMANCE OF DISRUPTIVE ADOLESCENTS

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A Commonality Analysis: Assessing Unique Effects of Person and Environment Variables on School Performance of Disruptive Adolescents

This paper reports on the use of commonality analysis as part of an evaluation of a learning program for disruptive, poorly achieving, and potentially delinquent urban junior high school students. The objectives were to obtain some understanding of how the program might have affected certain academic and non-academic outcomes and to assess the practicability of commonality analysis to further such understanding.

Background

Glaser (1978) pointed out that, although a growing number of behavioral programs have been introduced into the classroom, studies of these programs have focused primarily on decrease in disruptive behavior (and increase in attention to task). Although these variables are important, "learning outcomes that reflect changing knowledge and skill as performance objectives require attention to a variety of additional variables" (p. 236). Some of these variables were studied by Coleman et al. (1966), who reported that not only school, but also family and other background variables affect academic achievement. Mood (1971) suggested that models that combine a number of variables into a smaller number of sets are more easily comprehended than those with large numbers of individual variables. Mayeske et al. (1969), in their reanalysis of data from the Coleman report, used commonality analysis in an attempt to sort out the differential contribution of sets of school and background variables.

Commonality Analysis

Cooley and Lohnes (1976) support the use of commonality analysis in educational evaluation, calling it "an informative, conservatively safe method for most situations likely to arise in evaluations" (p. 219). Commonality analysis is an offshoot of multiple regression analysis that reveals the unique contribution of a variable or set of variables to the variance of a dependent measure.

Cooley and Leinhardt (1975) and DeVito (1976) have reported on its use in evaluation studies. It was chosen for this evaluation project because the predictor variables had not been ordered in an a priori fashion (which excluded the possibility of using stepwise multiple regression) and because generalizable results were not being sought. Tatsuoka (1973) stated that significance testing is of little importance in commonality analysis since "the technique is a heuristic device for exploring how a large set of variables may meaningfully be partitioned into several subsets, and for checking whether we have the 'right' indicators of the broad factors that a theory postulates to be related to the criterion in question" (p. 308).

The two major subsets of variables for this project were similar to those of Mayeske et al.: one was a collection of background variables (the person set), and the other was a collection of school variables (the environment set). The last included a treatment/no treatment category. The person-environment dichotomy was a response to Hunt's (1975) urging that the more traditional aptitude-treatment interaction framework be restated in less restrictive terms.

The PREP Program

The Preparation through Responsive Educational Programs (PREP) Project was based on behavior modification programs that had been successfully implemented with highly troublesome, anti-social, or delinquent young people (Burchard & Harig, 1976; Cohen & Filipczak, 1971; Fixsen, Phillips, & Wolf, 1973; Patterson, 1974; Stumphauzer, 1973; Tharp & Wetzel, 1969). PREP was conducted in three different school settings (suburban, urban, and rural) over a seven-year period. This study used data from youth enrolled during three different years in the urban school only.

PREP's educational program encompassed one school year for each student. Students were recommended for PREP by urban school staff on the basis of strong evidence of academic and/or social problems: failing grades, high number of disciplinary referrals, chronic absenteeism, poor performance on standardized tests, and teacher observations of poor classroom performance. Thereafter, PREP staff assessed each student's skills and problems in reference to specific entrance criteria, solicited informed consent of parent and child to participate, and randomly placed students in experimental or control groups as required for research purposes. In this way, PREP found itself dealing with the students who presented the school with the most severe academic and/or social problems each year.

PREP's program emphasized the acquisition not only of academic skills, but also of interpersonal and social skills. It also attempted to increase the school's reinforcing value to prompt positive behavior responses from students. Academic training in English and mathematics

(mainly in a self-instructional medium) was managed by PREP-trained teachers in classes of 16 to 24 students. Social skills training revolved around a set of social behaviors related to school, home, and environment: verbal behavior with teachers, administrators, parents, peers, and persons of authority; real-life solving of in-school and community problems; small-group interaction; and following instructions. These and other aspects of PREP have been described in a number of papers and articles (e.g., Filipczak, Archer, & Friedman, 1980; Filipczak, Friedman, & Reese, 1979; Filipczak, Storm, & Breiling, 1973).

PREP students also attended regular school classes--this helped insure that they were not labeled by enrollment in PREP and provided skills not a part of PREP training.

Within each of the different program elements, there was some type of reinforcement system for students and teaching staff. For students, this included the praise, ratings, and grades given by teachers. In addition, students earned either tangible rewards or activity rewards. The use of these different reinforcers was dictated by the severity of the students' problems and by the social milieu of the school. Teachers were reinforced by receiving feedback on improved performance of their students and college credit for successful performance in the training program.

During each of PREP's seven years, staff and external evaluators assessed program implementation and outcomes (academic, social, and community behavior). Large-scale and significant differences were observed in favor of treated groups each year for each setting, leading to both short- and long-term followup activities. One-year followup indicated maintenance of learned skill for PREP students, but decrements were observed in most measures across a longer four-year followup.

These favorable outcomes argued for some more systematic analysis. The urban school program offered a coherent set of data from three different groups of students. A range of outcomes significantly favoring the experimental groups during these three years provided the rationale for using this urban sample of youth in the commonality analysis.

Method

The sample consisted of 221 (M = 144, F = 77) junior high school students, 112 of whom participated in PREP and 109 of whom were controls. Although random assignment was sought, it was hampered by the unavailability of a pool of prospective students recommended before the start of the school year. Students placed in PREP tended to be those with larger-scale problems than those in the control group. Data were collected over a three-year period: 1974-75 (Year 1), 1975-76 (Year 2), and 1976-77 (Year 3).

Variables Included in the Study

Nine criterion variables were identified:

1. Final math grade.
2. Final English grade.
3. Final citizenship grade.
4. Final GPA.
5. SAT Reading score.
6. SAT Math score.
7. Days absent.
8. Suspensions.
9. Promoted/retained.

Final grades were those received at the end of the year during which the student participated in PREP in either the experimental or control group.

Predictor variables were divided into two sets:

Set 1: Person Variables

1. Age.
2. Sex.
3. Previous math grade.
4. Previous English grade.
5. Previous GPA.
6. Previous citizenship grade.
7. Previous SAT Reading score.
8. Previous SAT Math score.
9. Days absent previous year.
10. Number of siblings.

Previous grades and measures were those taken for the year prior to the student's participation in PREP.

Set 2: Environment Variables

1. PREP/Control.
2. Grade.
3. Teacher knowledge of behavioral principles (based on the amount of training by PREP Staff).

Description of Commonality Analysis

Commonality analysis is a method of interpreting regression analysis that requires partitioning the variance of a criterion variable into amounts contributed by each of the predictor variables alone (their

uniqueness) and a (confounded) amount contributed by all of the predictor variables (the commonality).

Commonality analysis can be explained by an example. Assume there are two predictor variables and that a multiple regression procedure has produced the usual zero order correlations between the criterion and each of the predictors (r_{y1}, r_{y2}) and a multiple correlation between the criterion and the two predictors ($R_{y.12}$). Although the squared multiple correlation, or coefficient of determination ($R^2_{y.12}$), is the amount of variance explained by the two predictors together, there is no way of knowing how much variance is explained by each predictor alone when both variables are in the equation. As Lohnes and Cooley (1978) put it, there is no way of knowing what the potential usefulness of the predictors is. "In this context, 'useful' refers to the utility of the predictor in estimating the dependent variable after all other predictors have been introduced" (p. 7).

Uniqueness, or usefulness, of a given predictor is determined by finding the difference between the R^2 of the full model and the R^2 of each of the other predictors. So, for variable 1, $U(1) = R^2_{y.12} - R^2_{y.2}$, and for variable 2, $U(2) = R^2_{y.12} - R^2_{y.1}$. The resulting number is a squared semi-partial correlation. It can also be viewed as the amount of additional variance explained when the variable in question is the last one added to the regression equation.

In addition to the usefulness of each variable, there is the commonality, which represents the confounded contribution to variance of all the predictors together. The commonality results from intercorrelations among predictors. It is found by subtracting the uniquenesses of each predictor from the R^2 of the full model: $C(12) = R^2_{y.12} - U(1) - U(2)$.

Commonality analysis can be applied to sets of variables as well as to individual variables. The major questions in this research have been how much environmental as opposed to person variables contributed to scores on achievement and other school-related behaviors and the extent to which the PREP program might have affected these scores and behaviors.

Data Analysis

Analyses were carried out using the regression subprogram of SPSS. A large amount of missing data prompted an initial series of hierarchical regressions based on Cohen and Cohen's (1975) work. Criterion variables were considered one by one. Each predictor variable was represented in two ways: (a) a designation of missing vs. not-missing for the particular predictor; and (2) the values of the variables for each case, with each missing value "plugged" with a constant. A significant F ratio ($p < .05$) permitted rejection of the null hypothesis that the data were missing randomly. This hypothesis was rejected for one or more predictor variables in the case of two criterion variables: days absent and SAT Reading.

The non-random nature of missing predictor variable data for these two variables restricted subsequent analyses to 85 cases (days absent) and 80 cases (SAT Reading). This reflected the use of correlations based on the same universe of data. For the other variables, a missing data correlation matrix was used, which Cohen and Cohen (1975) say is appropriate if it can be shown that missing data are missing randomly (p. 268). In terms of the SPSS regression subprogram, this made possible the use of Option 2; that is, pairwise deletion of missing data, rather than the default option (listwise deletion of missing data).

For each criterion variable, two regression analyses were performed. First the environment set, then the person set, was allowed to enter the

equation. This provided the squared correlation coefficient needed to find the uniqueness of the other variable set.

Results

Table 1 presents correlations among the predictor variables and each of the criterion variables; Table 2 indicates the amount of criterion variance explained by the full set of predictor variables.

Insert Tables 1 and 2 about here

A variable-by-variable study of the commonality analyses (see Tables 3 through 11) suggests that PREP's urban program, in combination with the grade and teacher knowledge variables, influenced classroom math and English grades, but had less influence on SAT scores, citizenship, absences, suspensions, and promotions/retentions. Neither variable set contributed substantially to an explanation of the final GPA for this urban sample.

Insert Tables 3 through 11 about here

Person variables appear to have been of some importance in the explanation of SAT score differences; they accounted for 43% of the variance in each case, while the environment set accounted for only 3% (Reading) and .03% (Math). Citizenship grade differences (for Year 2, since this was the only year data were available) were also attributable primarily to person variables.

These results do not necessarily argue against PREP's worth; they simply indicate that, for this group of students, differences in certain outcome measures were attributable to factors other than the PREP program.

Discussion

The full set of predictor variables explained a substantial amount of variance for several criterion variables. This suggests that these measures may be useful in other evaluation research in which commonality analysis is used. The fact that the effects of each predictor set were relatively unconfounded supports this suggestion. However, it should be stressed that the results of their use in this particular project are not meant to generalize to another set of data. The results presented here merely give some understanding of the effects of the PREP program in the urban setting.

Overall, the influence of the environment variables set appears to have been nearly equal to that of the person set (on variables where it had much influence at all). Differences on citizenship grades, SAT scores, and absences were explained much more by person variables than by environment variables. Neither set explained differences in number of suspensions or promotions/retentions. These results support PREP's techniques for improving English and mathematics classroom performance for the urban youth. They also argue for a continued, perhaps expanded attention to non-academic concerns--greater emphasis on the social skills aspects of the urban program's curriculum.

This analysis might have benefited from the inclusion of additional person variables. Included in the original plan were number of parents in the home, socioeconomic status, birth order, and scores on measures of

socialization, aggressiveness, assertiveness, locus of control, and self-esteem. Although data were available for all of these, it was too sparse to warrant its use in this project. The only variable with enough data was number of siblings. It was allowed to remain in the equation because of substantial correlations with several criterion variables.

This situation might have been averted if all components of the analysis had been pre-planned. But, since evaluation is often carried out with incomplete sets of data, perhaps this serves as an illustration that useful information can emerge in far from ideal circumstances.

These data do not provide unqualified support for PREP's urban program; for only a few of the criterion variables does it appear that a large amount of variance was explained by the environment (including PREP program) predictors. Larger quantities of variance explained by the person variables argue for conclusions about PREP that indicate a continuing need to search for ways to influence more than the amount of knowledge required in a particular academic subject or subjects.

The use of commonality analysis in programs such as PREP's urban effort could provide a ready and clear description to the staff of where program efforts should be enhanced or changed. In that sense, commonality analysis offers an addition to more traditional means of interpreting results of multiple regression in the context of evaluation. In fact, "commonality analysis can well be the frosting on the cake that gets the first attention" (Lohnes and Cooley, 1978, p. 17).

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Table 1

Correlation Matrix--Criterion and Predictor Variables

PREDICTOR VARIABLES	CRITERION VARIABLES								
	FINAL MATH GRADE[a]	FINAL ENG. GRADE	FINAL[b] CITIZENSHIP GRADE	FINAL GPA	SAT-READING	SAT-MATH[c]	DAYS ABSENT	SUSPENSIONS	PROMOTED/ RETAINED
PREP/Control	-.3591 (215)	-.3143 (218)	-.2070 (79)	-.1992 (220)	.0480 (196)	.1165 (57)	.0456 (186)	.0399 (156)	.2534 (203)
Grade	-.0922 (215)	.0109 (218)	.1948 (79)	.0055 (220)	.0653 (196)	.0467 (57)	-.0250 (186)	-.1142 (156)	-.0360 (203)
Teacher Knowledge of Behavioral Principles	-.0957 (215)	-.0224 (218)	.2070 (79)	.0458 (220)	-.0400 (196)	-.1165 (57)	.0297 (186)	-.0331 (156)	-.1388 (203)
Age	-.1501 (205)	-.1177 (208)	.0317 (72)	-.0956 (210)	-.0195 (187)	.0596 (57)	.0930 (176)	.0818 (149)	.0111 (193)
Sex	.0170 (215)	-.0179 (218)	.0615 (79)	.0180 (220)	-.0780 (196)	-.0926 (57)	.1204 (186)	-.1354 (156)	-.0612 (203)
Previous Math Grade	.2626 (162)	.2014 (165)	.2404 (62)	.2663 (167)	-.0088 (145)	.1322 (29)	-.2399 (162)	-.2173 (120)	-.2001 (154)
Previous English Grade	.3274 (162)	.3360 (166)	.1250 (61)	.3148 (167)	.1012 (145)	.2068 (30)	-.1863 (162)	-.1676 (119)	-.2490 (154)
Previous GPA	.2385 (168)	.3773 (171)	.5192 (60)	.3820 (173)	.1548 (151)	.4336 (38)	-.2736 (147)	-.2522 (128)	-.2594 (159)
Previous SAT - Reading	.1581 (210)	.3267 (213)	-.0741 (76)	.1854 (215)	.6724 (196)	.5130 (57)	.0036 (181)	.0449 (153)	-.1089 (200)
Previous SAT - Math[c]	.2626 (162)	.2014 (165)	.2404 (62)	.2663 (167)	-.0088 (145)	.1322 (29)	-.2399 (162)	-.2173 (120)	-.2001 (154)
Days Absent (Previous Year)	-.1602 (185)	.1784 (188)	-.5433 (62)	-.2266 (190)	.0652 (168)	.0135 (48)	.5585 (166)	.2786 (135)	.1448 (176)
Number Siblings	.0118 (136)	.1188 (135)	.1735 (37)	.0149 (136)	.0506 (129)	-.1897 (55)	.0886 (109)	.0357 (101)	.0462 (130)

[a]Numbers in parentheses refer to number of cases on which correlation is based.

[b]Applies to Year 2 only.

[c]Applies to Year 3 only.

Table 2

Variance Outcome Explained[a]

VARIABLE	R	R^2
Final Math Grade	.6020	.3623
Final English Grade	.6696	.4483
Final Citizenship Grade[b]	.7750	.6006
Final GPA	.5265	.2772
SAT - Reading	.6703	.4494
SAT - Math[c]	.6697	.4485
Days Absent	.6299	.3968
Suspensions	.4439	.1971
Promoted/Retained	.4256	.1812

[a]The environment variables were PREP/control, grade, and teacher knowledge of behavioral principles. Personal variables were age, sex, previous math score, previous English score, previous GPA, previous SAT Reading score, previous absences, and number of siblings.

[b]Year 2 only (Grade level not included in environment set. Number of siblings replaced by previous citizenship grade in person set.)

[c]Year 3 only (Grade level not included in environment set.)

Table 3

Final Math Grade (N = 102)

	ENVIRONMENT	PERSON
Unique to Environment	.2108	
Unique to Person		.1306
Common to Environment and Person	.0209	.0209
Σ^a	.2317	.1515

[a]Squared zero-order correlations of each variable set with the criterion.

Table 4

Final English Grade (N = 102)

	ENVIRONMENT	PERSON
Unique to Environment	.2190	
Unique to Person		.2067
Common to Environment and Person	.0226	.0226
Σ	.2416	.2293

Table 5

Final Citizenship Grade (N = 48)

	ENVIRONMENT[a]	PERSON[b]
Unique to Environment	.1221	
Unique to Person		.4983
Common to Environment and Person	-.0198	-.0198
Σ	.1023	.4785

[a]Grade level not included.

[b]Previous citizenship grade included; number of siblings not included.

Table 6

Final GPA (N = 102)

	ENVIRONMENT	PERSON
Unique to Environment	.1085	
Unique to Person		.1786
Common to Environment and Person	-.0099	-.0099
Σ	.0986	.1687

Table 7

SAT Math - Year 3 (N = 20)

	PREP/CONTROL	PERSON
Unique to PREP/Control	.0003	
Unique to Person		.4349
Common to PREP/Control and Person	.0133	.0133
Σ	.0136	.4482

Table 8

SAT Reading (N = 80)[a]

	ENVIRONMENT	PERSON
Unique to Environment	.0348	
Unique to Person		.4340
Common to Environment and Person	-.0194	-.0194
Σ	.0154	.4146

[a]Reduced number of subjects resulted from non-randomness of missing data on two predictor variables and consequent use of listwise deletion of cases.

Table 9

Days Absent (N = 85)[a]

	ENVIRONMENT	PERSON
Unique to Environment	.0558	
Unique to Person		.3272
Common to Environment and Person	.0138	.0138
Σ	.0696	.3410

[a]Reduced number of subjects resulted from non-randomness of missing data on two predictor variables and consequent use of listwise deletion of cases.

Table 10

Suspensions (N = 101)

	ENVIRONMENT	PERSON
Unique to Environment	.0838	
Unique to Person		.1208
Common to Environment and Person	-.0075	-.0075
Σ	.0763	.1133

Table 11

Promoted/Retained (N = 102)

	ENVIRONMENT	PERSON
Unique to Environment	.1210	
Unique to Person		.0919
Common to Environment and Person	-.0317	-.0317
Σ	.0893	.0602